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recognize that your keen senses and hair-trigger decision making have allowed you the opportunity to pay the large repair bill you know is coming.

Again, check the accuracy of the engine instruments before committing to a teardown, but if there is no end play in the crankshaft or if a rise in oil pressure is accompanied by a stiffly turning propeller-expect the worst. And by the same token, if you notice a prop acting stiff during preflight (you do pull the prop through to check for compression humps?), it would be best to seek the counsel of the sharpest mechanic on the field before proceeding with the flight.

This is particularly true if this is a sudden onset, or right after an overhaul or major engine work. It will not get better with flying hours and must be diagnosed as the crank could seize.

REMEDIAL MEASURES

For engines in which oil pressure sags low on the gauge—especially engines with two or three TBO runs on them—the only corrective action available, externally, is to increase the oil's viscosity, thereby decreasing flow and increasing pressure. Verify that there is sufficient oil in the sump, but it would have to be down to only two or three quarts remaining in a four-cylinder engine before oil pressure starts dropping at cruise or the needle swings with attitude changes. Oil temps would be climbing as well in this situation.

Increasing pressure can be done to a limited degree by changing the oil grade and brand. It can also be accomplished by lowering the oil temperature.

Changing oil pumps or replacing relief valve springs will not fix a problem with a worn-out crankcase. And running clearances that push the maximums or wear beyond allowable limits can only be repaired by replacing big-ticket items like crankshafts and cams.

Try repairing the baffling. Especially around the oil cooler, change to a straight-weight oil appropriate for your OAT, and keep the oil clean. Most engines will run just fine at the bottom of the green arc, but dropping lower or rising well above the range is a sure sign of trouble with a capitol PSI. Last, fits and clearances during overhaul are critical for good pressure.

Nose Wheel Shimmy

Before you blame the shimmy damper, there are several areas subject to wear that need inspection first

BY MIKE BERRY, IA

Certainly, any discussion involving violent shaking of the nose wheel and nose gear structure during take-off and landing would include the servicing of the dampener, and we will be doing a story on that topic next issue. But there are other causes for nose wheel shimmy and some are very subtle in their participation in the event.

SHAKE, RATTLE, AND ROLL

Pilot reports of nose wheel shimmy on landing are often vague and devoid of pertinent details regarding speed, load on the nose, and the degree to which the aircraft is rattling along. One such report came back to the shop in the form of a one-line description that said, "the windshield is trying to leave the airplane on landing."

A similar squawk from a California flight school found student pilots reporting severe "earthquake movements coming from the engine during landing." Perhaps the most telling was the squawk that read "floor-mounted GPS head damaged by number-one nav/com."

In the final analysis, it was discovered that the number one radio had a habit of sliding out of its tray due to a severe nose wheel shimmy on take-off. Gravity and acceleration took over at that point and the GPS head suffered the consequences. Generally, these kinds of squawks result in the rebuilding of the shimmy dampener. When that effort isn't enough, there are a few other places to look for cumulative problems and they all start with the nose wheel.

CUPPING AND GRINDING

Nose tires are very round when new but tend to wear at odd angles and flatten out in spots as they get older. This "cupping" of the tire throws the assembly out of balance and aggravates a wear pattern that continues as long as the tire remains with the airplane.

While balance is critical, quick turns and rough ground operation will also play a role in getting the tire to bounce and vibrate on landing—especially when under a load. Any shimmy troubleshooting should include a thorough look at the nose tire, nose wheel bearings, and the attaching bolts, spacers, and axles used to secure the tire to the nose gear fork.

The tire should be checked for balance, the bearings inspected for rough spots (sometimes called water spots due to the corrosive nature of moisture left in an inactive bearing), and spacers should be inspected for rotation and galling against the nose gear forks.

Rotate the wheel on the axle and listen for roughness transmitted through the fork. The bearings should run smooth and virtually noise free. As always, check the tire pressure. Over-inflated tires will transmit the slightest imperfection in the runway through the steering system, working the shimmy dampener to its maximum.

Under-inflated tires will wallow around on the tarmac causing excessive wear and flexing. Either case will stress the nose gear strut and steering systems beyond the normal expectation of a design built on a compromise of weight and strength.

Next on the inspection list will be the shimmy dampener attachment. No matter how well serviced the dampener is, a loose attach point will make null and void any dampening affect. Grab the dampener and check for any lateral or vertical play in the attachment.

The hardware holding the dampener in place is constantly under a shear load and the wear occurring at bolts and bushings is an accelerating one. Remove the bolts and bushings and check for wear on their diameters. Even a little wear felt with a thumb nail is enough to reject the hardware.

(As always, make certain to draw a diagram of the attaching bolt and washer placement and note the direction in which the bolt is placed. Too many

aircraft have landed gear up due to a bolt head placed in the wrong direction that catches on the nose gear retract structure.)

Next, with the airplane sitting level on the nose gear, grab the upper and lower torque links and check for the same kind of vertical and lateral play. It's normal for the attaching bolts to be somewhat loose in their respective links and they should be free to rotate.

However, if the link can be moved on the bolt and bushing diameter, then the attaching hardware should be removed and inspected for wear. Often enough, the bolts are fine but the aluminum torque link has worn a little causing the link to rattle on the bushings. In some cases, replacing the bolts and bushings with new will bring the tolerances back into limits, but a worn torque link will only accelerate its wear pattern and the part will need to be replaced eventually.

TORQUE THE LINKS

Making sure that the torque link hardware is in good shape is half the battle. Proper assembly of the links to the strut is the other half. But preparation for bolt inspection and assembly is important and some guidelines should be followed.

Any time a bolt is removed from a pair of torque links, it will first be necessary to allow all the air to leave the strut housing. Failure to do so will result in the uncontrolled birthing of the lower strut from the upper strut housing.

Sometimes, disconnecting the torque links from the strut or nose gear fork will also result in the rapid turning of the nose wheel and fork assembly to one side. This explosion can break bones. It is recommended that the nose wheel be lifted off the ground by placing weight on the stabilizer or jacking the aircraft off the ground.

Remove the valve core from the strut or depress the core until all air is removed. At this point, the torque link bolts can be removed and inspected. Again, be sure to note the location of the bolts and the direction in which they are installed.

It's important to do this on any aircraft, regardless of whether it is equipped with a retractable gear or not. It should also be noted that any bolt subject to a rotational force such as rod ends, torque link bolts, engine control cable attachments, and the like, should be secured with a castle nut and a cotter pin. It is preferable to a lock nut that may have lost its primary locking function and far better than a jam nut.

Clean all parts in solvent and blow-dry with compressed air. Check bolts and bushings for wear and galling. If the bolt is equipped with a grease hole drilled through the center, make sure it is free to transfer grease. Note the markings on the bolt head.

Many landing-gear bolts are "close tolerance" or "special" bolts, which are different from the everyday, run-of-the-mill tractor stuff used in other areas. A close-tolerance bolt will have a slightly larger diameter than a standard bolt.

Usually it's around 0.003-inch bigger. It is extremely important to understand that you do not install a standard bolt in a close-tolerance bolt hole. Your IA will frown on the practice and the FAA will hold you up like an enforcement poster child for the trainees in Oklahoma City.

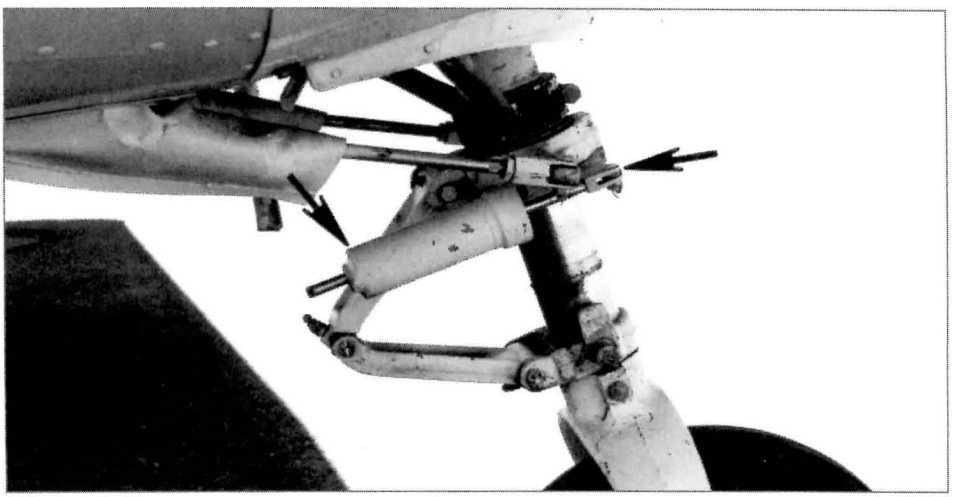
The nose tire must be balanced and the bearings, races, spacers, and attaching bolts must be inspected for condition and wear.

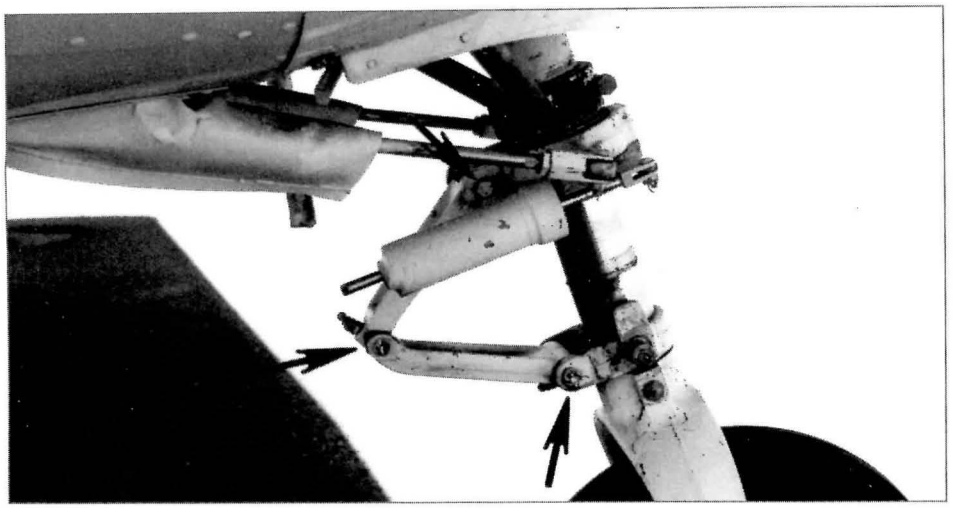
Any "special" bolt or "close-tolerance" bolt will have some special marking on the top of the bolt head. Look for rounded indents, the letters "SP," or other similar markings.

Virtually all close-tolerance and "special" bolts have a very fine, machined finish to the bolt length and are smooth and shiny. They also lack the gold cadmium color found with most standard bolts.

Check the aluminum torque links for worn holes and galling in the area of spacers and washers. Some irregularities can be removed with a finish file, but rework for egg-shaped holes is not permitted. Even though reaming to the next larger size and installing a bushing sounds much better than buying a new link, it is also asking for trouble.

Any shimmy complaint will start with the condition and security of the shimmy dampener. Check all attach points for wear and make sure the dampener is properly serviced.





Torque link attach points should be inspected for wear and galling. Be sure to "unload" the strut before attempting to remove the bolts.

The area around the bolt hole is usually small, and removing material will weaken the link. Try replacing the bolts and bushings with new before you change the link.

ASSEMBLING LINKS

After a thorough inspection, reassemble the links to the strut, making note of the position of all spacers, washers, and bolts. If you have lost the schematic you drew showing the placement of these parts, review the service and parts manual for placement. Unfortunately, these pictures are sometimes unclear, and a certain amount of guess work is needed. There are, however, some key things to remember during assembly.

Never tighten a torque link bolt so tight that it can't be rotated with a little effort using a wrench. These bolts are not supposed to hold the link tight. Rather, they are supposed to retain and locate the bushings and bolts for the shear load they were designed to take.

Do not tighten the bolts in an effort to eliminate any play. The torque link arms are very strong but they do not like to bend. Over-torque of an attaching bolt will crack the torque link ears and can cause a loss of control at the most inopportune time.

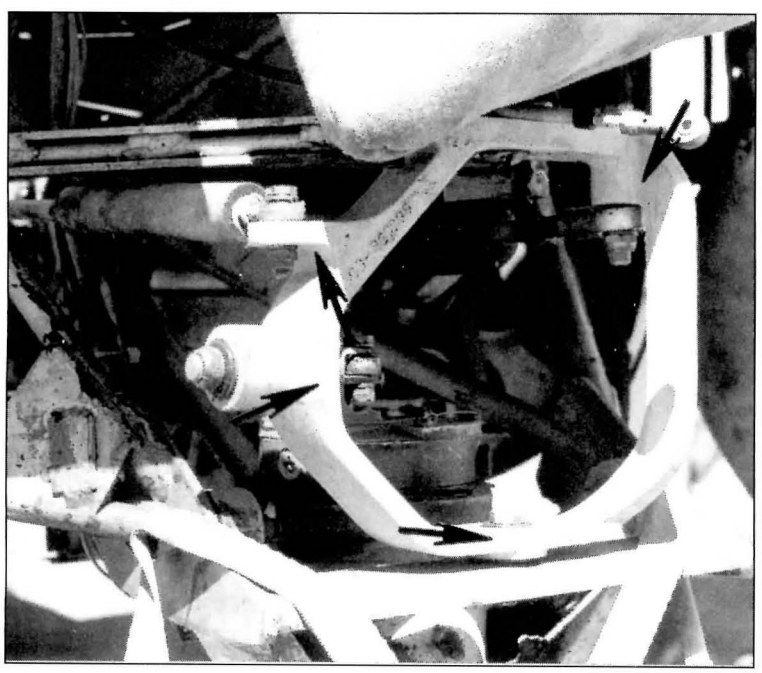
Sometimes, washers and spacers are used between the link and the nose gear fork and lower strut tube. Adding washers to take up any side play is fine, but don't force them into the slot.

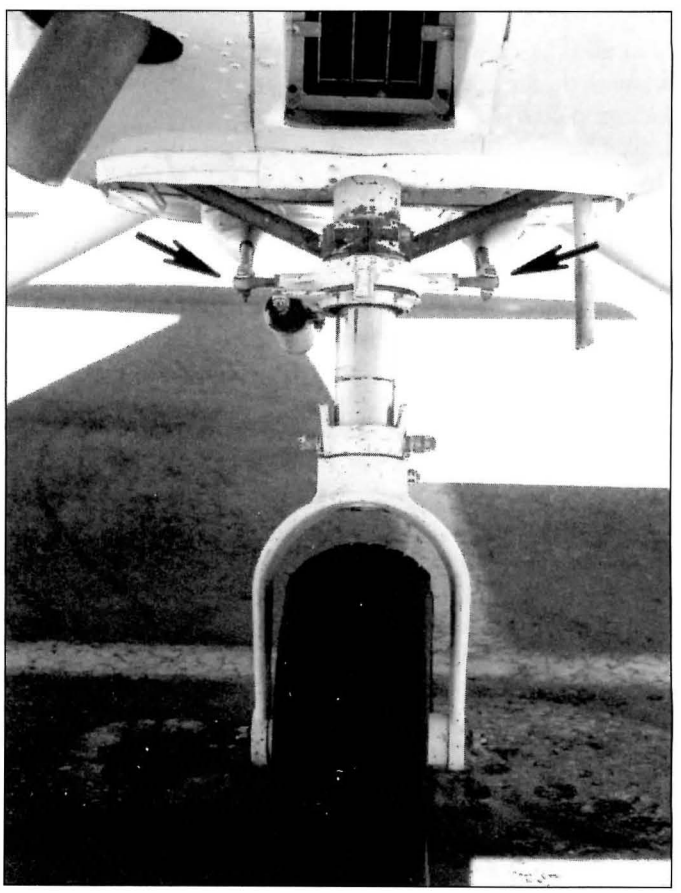
With landing gear components that move, too little play is a liability and the gear that's stiff to move will create problems with retraction and landing strut loads. When completely assembled, recheck that all cotter pins are installed, the hinge points are lubricated, and that the nose wheel will move up and down without binding in the links.

STRUT COLLARS AND STEERING

Aircraft that shake and rattle during take-off and landing will exhibit unusual wear patterns to other systems unrelated to the nose gear itself. For instance, the bearing blocks that secure the rudder pedal torque tubes to the floor or fuselage structure will wear the thrust side of the block with every push of the rudder pedal.

Right, check the steering rod attach points at the strut and at the rudder torque tube located in the lower forward cockpit area. Torque tube bearing blocks should also be inspected. Below, small cumulative wear patterns in the nose steering will create one big loose clearance that can result in a severe nose shimmy.





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Combine that with a shimmy that induces a rapid back-and-forth vibration and the bearing blocks gall with the added stress. The same can be said for steering collars, rod end hardware, and steering tube dampeners.

The cumulative clearances and the extra wear rates result in a dynamic oscillation that starts as a slight lateral shimmy of the nose wheel and ends with a violent shaking of the entire airplane. It's as if everything has come loose in the fuselage and only good living and the blessings of the Almighty are enough to hold the crumbling bird together. It's at times like these that just getting back to the ramp with all the pieces intact is considered a job well done.

Some steering collars can be shimmed to reduce the vertical and lateral play on the strut, and rod ends can be replaced with new parts. Be certain to check the steering rod attach points and the rudder pedal torque tubes for loose bolts, worn linkages, and egg-shaped bearing blocks. If a nose wheel shimmy has been allowed to continue, you can be assured that these components have been adversely affected by the strain.

SHIMMY IN THE EXTREME

Extreme nose wheel shimmy conditions can cause collateral damage to cowling mount supports, tube steel engine mounts, instrument panel supports, and primary flight instruments. It also makes landing operations much more difficult, even for the experienced pilot.

Heavy braking tends to intensify the problem by loading the nose wheel. The natural reaction is to pull back on the elevator, which will lessen the severity of the shimmy but makes directional control more difficult.

The NTSB has a file dedicated solely to those aircraft that have departed the runway for this very reason. It is in your best interest to determine the cause of any shimmy problem and make the necessary repairs to the nose wheel and steering system as soon as possible.

As always, if in doubt about hardware location, or if you are unsure about how loose or tight an assembly should be, consult your mechanic and the aircraft maintenance and service manual.

Ignition Switches

The key start ignition switch has evolved into a many functioned and complicated piece of gear.

BY **LPM STAFF**

It will leave you with a nagging doubt until the duties of the take-off roll pry your attention away from that damn loose ignition switch. The magnetos checked fine on run-up but the mag switch tumblers are completely worn out.

The key can be removed at any time, regardless of position, and the switch detent has long since relieved itself from the original design. That dark brood of a thought only comes back for a brief instant as the elevator takes hold and you ease the nose off the ground—knowing full well that any loss in power at this point would put you somewhere between the trees and the dirt.

It has long been known that the key style locks and ignition switches used in aviation applications years ago were not assembled from materials and design criteria that included the idea that you would be flying this bird 40 years later. Weighing only seven ounces, the average key-type ignition switch is a compromise in weight, material, function and purpose; and yet, the little twist-to-start switch will outlast virtually any accessory or component attached to the airframe. It's an enigma to be sure, but in large part, it works, and works well, considering that the average ignition switch will cycle some 5,300 times over the course of an engine's life.

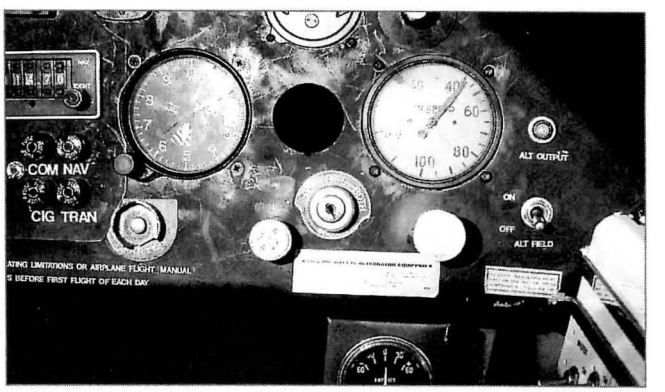
In the early 1940s magneto switches were made by Mil Spec suppliers who built large, heavy, rotating switches, which were used to alternately ground and open the magneto primary leads. Bendix took up the lucrative line in April of 1947 when they introduced a low profile, lightweight switch, which performed the same grounding function as their predecessors at a better price to the makers.

In its simplest form, the Bendix ignition switch provides individual operation of either magneto while providing other detents for both and off. The operation of this switch and all variations of the unit is made up of functions that selectively ground the magneto P-lead (or primary lead) on the magneto you don't want operating and opening the lead to the magneto you want on line.

If both mags are to be on line, then "Both" is selected and the left and right P-leads are opened. If "Off" is selected, then both magnetos are grounded through the switch to an airframe ground point and all ignition function is removed. This design criteria has been in place since the dawn of time and is born of the assumption that a wire will break open before it grounds out, thus providing ignition to the engine in a system-fail mode. (Never mind that the magneto P-lead is encased in a steel shield braid intended to limit noise while offering a prime path for ground with only a little bit of chafing.)

TWIST AND START

In 1960, Bendix produced the new generation of magneto switches, which were



The Bendix "Ground Magneto" switch (GM) is an ignition switch in its simplest form. Note the remote starter button located to the left of the mag switch.